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Materiel Test Procedure 8-3-503
U. S. Army Infantry Board

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE

DURABILITY AND RELIABILITY
(CB EQUIPMENT)

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide methods of evaluating the durability and functional reliability of chemical and biological (CB) equipment.

2. BACKGROUND

During recent years the military procurement system has imposed increasingly rigid requirements for the inclusion of inherent characteristics enhancing durability and reliability in the design and production of military equipment. These characteristics are tested exhaustively under controlled conditions during the design and prototype production phases and the engineering test phase of the development cycle. However, the ultimate measure of the worth of an item is its immediate availability in operable condition when required for use in combat. The service test will determine durability and reliability of the test item in the simulated combat environment.

The terms "durability" and "reliability" as applied in the service test of military equipment are defined as follows:

Durability -- The ability to exist for a required period under stated environmental conditions with retention of original qualities and capabilities.

Reliability -- The probability that an item or system will perform its intended function for a required period of time under stated environmental conditions.

3. REQUIRED EQUIPMENT

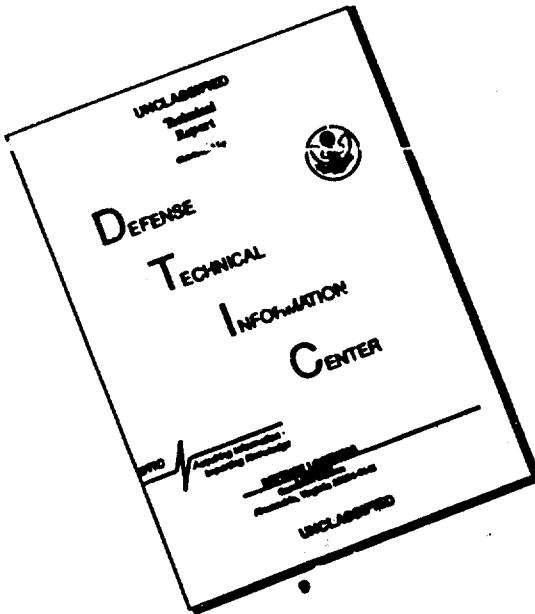
There are no special equipment requirements for this portion of the commodity service test.

4. REFERENCES

- A. MIL-HDBK-217(), Military Standardization Handbook, Reliability and Systems Effectiveness Prediction, Volumes I and II.
- B. AMC Regulation 11-33, AMC Chemical and Biological Weapons Surety Program.
- C. AMC Reliability Handbook, Volumes I and II.
- D. AMC Pamphlet 706-134, Engineering Design Handbook, Maintainability Guide for Design.
- E. Paul G. Hoel, Introduction to Mathematical Statistics, John Wiley and Sons, Inc., 1960.
- F. Howard W. Alexander, Elements of Mathematical Statistics,

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- John Wiley and Sons, Inc., 1961.
- G. Frederick Mosteller, Robert E. Rourke, and George B. Thomas, Jr., Probability with Statistical Applications, Addison-Wesley Publishing Company, Inc., 1961.
- H. Theodore Baumeister and Lionel S. Marks, Standard Handbook for Mechanical Engineers, McGraw-Hill Book Company, Seventh Edition, 1967.
- I. MTP 6-1-003, Determination of Sample Size.
- J. MTP 6-1-004, Statistical Methods of Reliability Determination
- K. MTP 6-2-503, Reliability Testing.

5. SCOPE

5.1 SUMMARY

a. The scope of this MTP includes all chemical and biological items normally issued to combat and service units and individuals.

b. The durability and reliability of a test item is essentially determined by statistical analysis of data collected during conduct of all phases of the service test; special tests are not usually required. The results of well planned commodity operational subtests and applicable common subtests will normally provide the necessary data. In some cases, however, it may be necessary to conduct special life tests and/or additional replications of portions of the normal tests.

c. The procedures outlined in paragraph 6 of this MTP are intended to guide the test planner in the preparation of other subtests so that they will be designed to provide the data required for statistical determination of durability, a numerical index of predicted reliability, and an associated confidence level in that prediction expressed as a percentage. With this in mind, CB items of equipment are treated first as a group and then in seven categories according to type and function.

d. Guidance for data collection is presented in separate paragraphs as listed below.

- 1) General -- data requirements applicable to all categories of equipment.
- 2) Auxiliary Equipment.
- 3) Collective Protection Systems.
- 4) Decontamination Equipment.
- 5) Detection and Surveillance Equipment.
- 6) Dissemination Devices.
- 7) Munitions.
- 8) Individual Protective Equipment.

5.2 LIMITATIONS

Certain constraints may sharply limit the quantity and quality of the data which can be collected. These constraints may include (1) fixed or limited number of test samples, (2) limited time for completion of tests, (3) limited manpower and/or funds, (4) limited logistical support, and (5) availability of restricted areas for utilization of actual or simulated CB Munitions. Prior

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knowledge of these constraints, specific information about the test item and applicable criteria, and the assistance of a statistician will be required to determine the kinds of tests and the number of test replications which will produce the most meaningful reliability data.

6. PROCEDURES

6.1 PREPARATION FOR TEST

- a. Prepare check lists of specific things which might affect durability and reliability of the CB test item. The check lists should be keyed to pertinent aspects of subtests.
- b. Prepare data collection forms prior to conducting the tests. The data forms should be available to test personnel at all times for timely and methodical recording of data.
- c. Define the terms used for recording of critical data. For example the exact meaning of the terms "failure", "malfunction", and "operations" as applied to the specific CB test item must be clear.

6.2 TEST CONDUCT

- a. The qualities which lead to durability and reliability are not independent qualities which can be measured and expressed numerically without consideration of all other factors which contribute to system effectiveness. It is necessary to correlate the concepts of durability, reliability, and maintainability with each other and with their influence on operational readiness, availability, and overall system effectiveness. The data collected during all subtests must be included in the statistical analysis and evaluation.
- b. Since the quantitative expression and measurement of reliability requires an understanding of the concepts of probability and statistics, the test plan will be prepared in coordination with a statistician or mathematician acquainted with statistical methods. It may be necessary to derive a formula for inclusion in the test plan which will determine hours of successful operation required to permit continuation of the test.
- c. Specific kinds of information useful in the statistical analysis and final evaluation are presented in the paragraphs which follow. The listings are representative only and can serve as a partial check list, to be expanded by the test planner in accordance with the mission and criteria of the particular CB item under test.

6.2.1 General - Data Applicable to All categories of Equipment

Records kept throughout all phases of operational and common subtests should reflect the following information in terms applicable to the unique qualities of the particular test item:

- a. Number of test samples.
- b. Number of test soldiers using the test sample.
- c. Incremental and cumulative time, each phase of test.
- d. Failures, each test sample (as defined for the particular test item).

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- e. Cause of each failure.
- f. Cumulative failures.
- g. Time between failures, (from which mean time between failures (MTBF) is computed).
- h. Time to repair, (from which mean time to repair (MTTR) is computed).
 - i. Number of operations, each test sample (cycles, time, miles, events, etc.).
 - j. Cumulative number of operations.
 - k. Malfunctions by type, each test sample.
 - l. Cause of each malfunction.
 - m. Cumulative malfunctions by type.
 - n. Breakage.
 - o. Cause of breakage.

6.2.2 Auxiliary Equipment

- a. These are items which are used in such things as shipment, filling and field impregnation of clothing. They are generally used in conjunction with other items.
- b. Observe and record the following throughout the service test:

- 1) Damage to shipping containers, field transport cases, or other containers.
- 2) Agent or other chemical leakage.
- 3) Efficiency of couplings.
- 4) Condition of flexible hose,
- 5) Corrosion.
- 6) Efficiency of valve operation.
- 7) Apparent deterioration of impregnate or other chemical.

6.2.3 Collective Protection Systems

- a. These systems are designed to provide and maintain filtered air under positive pressure at a level which precludes the infiltration of hazardous levels of toxic agents. These systems are adaptable for use with field medical facilities, and other shelters such as command posts, communication centers, portable pressurized shelters, and certain vehicles and vans. Included in this category are:

- 1) Collective Protection Systems, Vehicles and Vans.
- 2) Collective Protection Systems, Field Shelters.
- 3) Collective Protection Systems, Fixed Installations.

- b. Observe and record the following throughout the service test:

- 1) Damage or loss of efficiency from repeated erection and dismantling.
- 2) Abrasion, tears, or holes in fabric or plastic shelter walls.
- 3) Breakage, wear, or loss of efficiency of closures (slide fasteners, buttons, snap fasteners, cord ties).

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- 4) Abrasion and tears from repeated use of permeable membrane doorways.
- 5) Abrasion and cracking of flexible air supply hoses.
- 6) Damage or undue wear of air supply hose connectors from repeated coupling and uncoupling.
- 7) Valve efficiency after repeated or long use.
- 8) Useful life of gas particulate filters.
- 9) Efficiency of compressors, engines, and motors after long use.
- 10) Undue wear of parts.

6.2.4 Decontamination Equipment

a. These items of equipment are designed to facilitate the process of making any person, object, or area, safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents. Included in this category are:

- 1) Decontaminating Apparatus, Portable.
 - 2) Decontaminating Apparatus, Power Driven, Vehicular or Skid Mounted.
 - 3) Decontamination Kit, Individual, Field.
- b. Observe and record the following throughout the service test:
- 1) Damage, corrosion, or leakage of chemical containers.
 - 2) Efficiency of decontamination process and materials.
 - 3) Deterioration of decontaminating materials.
 - 4) Efficiency of valve and nozzle operation.
 - 5) Leakage of gas from cartridge used to pressurize portable decontamination apparatus.
 - 6) Abrasion or cracking of flexible hoses.
 - 7) Efficiency of compressors, engines, and motors after long use.
 - 8) Undue wear of parts.

6.2.5 Detection and Surveillance Equipment

a. This equipment is intended to provide friendly troops with sufficient notice of a CB agent attack to enable them to take adequate protective measures. Also included in this category are items with the capability of sampling and identifying chemical agents, detection of personnel, or marking and tracking personnel. This classification of equipment includes:

- 1) Alarms, Biological.
- 2) Alarms, Chemical.
- 3) Chemical Agent Detector Kit.
- 4) Sampling and Analyzing Kit.
- 5) Personnel Detector.
- 6) Marking, Tracking, and Identification System.
- 7) Field Laboratories.

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Observe and record the following throughout the service test:

- 1) Alarm response to specified concentrations of agent simulants.
- 2) Stability of adjustments and controls of alarm devices.
- 3) Battery life of alarm devices.
- 4) False responses to normal air contaminants.
- 5) Mechanical wear.
- 6) Damage to containers, kits, transport cases, and internal parts after repeated use and field transportation.
- 7) Efficiency of analyzing agents and materials after repeated exposure to air (times opened, length of exposure).
- 8) Loss of analyzing agent efficiency with age.
- 9) Deterioration of aspirator bulbs.

6.2.6 Dissemination Devices

a. This equipment is intended for use in distributing relatively large quantities of CB agents or smoke over a large area. Such items are designed to disseminate bulk micropulverized powders, liquid agents, or slurries. These items include the following:

- 1) Dispenser, Riot Control Agent, Portable.
- 2) Dispenser, Riot Control Agent, Vehicular or Helicopter Mounted.
- 3) Generator/Dispenser Devices, Field, Biological.
- 4) Screening Smoke Dissemination Sub-System for Army Aircraft.
- 5) Tanks, Spray, Antipersonnel, Anticrop and Defoliant Agent
- 6) Generators, Smoke, Mechanical.
- 7) Flame Throwers.

b. Observe and record the following throughout the service test:

- 1) Wear of mechanical parts, valves, and controls.
- 2) Leakage and corrosion.
- 3) Firing data - retention of design characteristics after repeated use with respect to range, duration, and dispersion pattern.
- 4) Damage from field transport and field use.

6.2.7 Munitions

a. These items of equipment are designed for the delivery of CB agents, smoke, or incendiaries to selected targets, and include:

- 1) Bomblets, Biological
- 2) Bomblets, Chemical.
- 3) DIACBA Munitions.
- 4) Target and Area Smoke Marking Munition Sub-System for Army Aircraft.
- 5) Generators, Smoke, Pot.

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- 6) Grenades, Hand, or Weapon Launched, Smoke/Incendiary.
- 7) Grenades, Hand, or Weapon Launched, Smoke, Colored Marking.
- 8) Grenades, Hand, Riot Control.
- 9) Mine, Land, Chemical or Flame.
- 10) Multiple Sub-Munitions Systems, Riot Control
- 11) Projectile and Cartridges, Chemical, Biological, Smoke/Incendiary.
- 12) Warheads, Guided Missile, Biological Agent.
- 13) Warheads, Guided Missile, Chemical Agent.
- 14) Warheads, Rocket, Chemical Agent.

b. Observe and record the following throughout the service test:

- 1) Leakage and corrosion.
- 2) Fuse timing irregularities.
- 3) Uniformity of dispersion.
- 4) Number of duds.
- 5) Damage from field transportation and handling.

6.2.8 Individual Protective Equipment

a. These items of equipment are designed to protect the individual from the effects of CB agents by: (1) preventing the entry of such agents into the respiratory system, or (2) decreasing the cutaneous and percutaneous hazards. Included in this category are:

- 1) Boots, Protective.
- 2) Breathing Apparatus, Self-Contained Air/Oxygen Supply.
- 3) Ensemble, Protective, Supplied Air.
- 4) Gloves, Protective.
- 5) Hoods, Protective.
- 6) Liners, Protective.
- 7) Masks, Protective.
- 8) Overgarment, Protective, Disposable.
- 9) Respirators.
- 10) Casualty Bags.

b. Observe and record the following throughout the service test:

- 1) Effects of repeated donning and doffing.
- 2) Abrasion, tears, cracks, and punctures resulting from wear under simulated combat conditions and areas while walking, running, and crawling over rough terrain to include heavily wooded areas containing sand, rock, brush, and briars.
- 3) Length of time when protective clothing can be worn and if not torn or ripped still provide protection.

NOTE: This determination is made through cooperative effort between the service test board and the engineering test agency.

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- 4) Deterioration after long periods of carrying in the packed condition by individual test soldiers.
- 5) Cracks, abrasions, and leaks in flexible hoses.
- 6) Undue wear or leaks in coupling devices.
- 7) Damage to and defects in closures (slide fasteners, buttons, draw cords, snap fasteners, etc.).
- 8) Valve functioning.
- 9) Deterioration or excessive wear of carrying straps.
- 10) Functional effectiveness of filter units.
- 11) Leaks or other defects at eye-ring, inlet valves, and voicemitter outlet valve assemblies of facemasks.
- 12) Effective gas life of filters.
- 13) Retention of eyepiece transparency.
- 14) Retention of sealing effectiveness of facepiece.
- 15) Resistance to fire.

6.3 TEST DATA

The test data shall be the data recorded throughout the service test of all failures, malfunctions, breakage, and other occurrences or incidents having a bearing on the durability and reliability of the test item.

6.4 DATA REDUCTION AND PRESENTATION

a. All data having a bearing on the durability and reliability of the test item shall be extracted, collated, statistically analyzed, and evaluated to determine if the item meets the established durability and reliability criteria.

b. The results shall be presented in narrative form supplemented with tables, charts, graphs, and photographs, as applicable. A brief explanation of the statistical methods employed shall be included.